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EFFECT OF TEMPERATURE ON TOXICITY OF DDT*

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Experiments conducted in cabinets in the greenhouse during the winter of 1945 showed that temperature had a marked effect on the toxicity of DDT to larvae of the diamondback moth, *Plutella maculipennis* (Curt.), and the greenhouse leaf tier, *Phlyctaenia rubigalis* (Guen.), the mortality decreasing as the temperature increased within the range of the tests. The optimum temperature for maximum kill has not yet been determined because it was not possible to run tests at all desired temperatures with the equipment available.

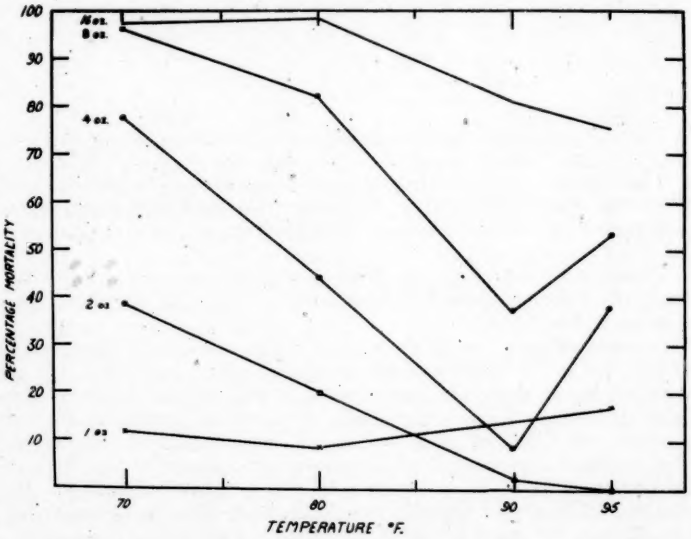

Fig. 1. Effect of temperature on contact action of DDT to diamondback moth larvae.

EQUIPMENT

Two types of temperature control cabinets were used, (1) an insulated cabinet of about 4 cubic feet capacity which was thermostatically controlled to within a range of about 2 degrees F., provided the temperature of the room was lower than that inside the cabinet, and (2) three rather crude cabinets made of wooden boxes covered with rock wool and provided with glass fronts. Heat was supplied by means of electric light bulbs which for the first few tests were manually operated, but later were controlled by thermostats. As none of the cabinets were provided with forced circulation there was considerable variation in temperature between the top and bottom within them. For this reason, and because the temperature of the cabinets sometimes exceeded the desired temperature for short periods owing to heating of the greenhouse, the temperature

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figures given in this paper cannot be considered as exact. However, enough data were obtained to establish the relative effect of temperature conditions at intervals of about 10°F. within the range between 60°F. and 95°F.

EFFECT OF TEMPERATURE ON CONTACT ACTION OF DDT

The DDT was applied as a contact spray to the larvae which were then placed with about 3 square inches of unsprayed cabbage foliage in straight-sided pint jars, provided with a strip of moist dental cotton and covered with factory cotton. Mortality counts were made daily or at the end of three days, and in addition the percentage of the foliage consumed was estimated. In the following records all mortality and feeding figures refer, unless otherwise stated, to the final examination 3 days after spraying.

Table 1—Effect of temperature on contact action of DDT on last instar diamondback moth larvae.

Oz. DDT per 100 gal.	Temperature range 60°–70° F. No. larvae	% mort.	% foliage eaten	70°–80° F. % mort.	% foliage eaten	85°–100° F. % mort.	% foliage eaten
0.5	20	15.0	22.5	20.0	22.5	0	90.0
1.0	20	45.0	6.5	50.0	9.0	5.0	55.5
2.0	30	83.0	1.6	53.3	16.6	3.3	35.0
4.0	50	100.0	T	94.0	T	10.0	27.0

The sprays used in these tests were, unless otherwise stated, of the emulsion type made by diluting with water the following concentrate: DDT, 20 g.; Triton X-100, 10 cc.; Velsicol AR-60, 70 cc., which gives a total volume of 100 cc.

Three sets of preliminary tests conducted in the cabinets by manually operating the lights gave strikingly different results for different temperatures, as shown in Table 1.

In a second series, tests were run in duplicate in the thermostatically controlled cabinet at 70°, 80° and 90° and a single test at 95°F. A total of six jars with 15 larvae each was used for each rate at the different temperatures, except at 95° where 3 jars were used. The results, presented in Table 2 and Fig. 1, show steadily increasing kill as the temperature was lowered from 90° to 70°F. Table 2 also shows that in general the amount of feeding was inversely proportional to the larval mortality. It will be noted that at the two highest rates, viz., 8 and 16 oz. per 100 gal., practically no feeding was done at 70° and 80°, while at 90° and 95° from 3.3 to 13.9% of the foliage was consumed.

The results of the one test at 95°F. were not very consistent, rapid drying of the leaves in the jars possibly having caused somwhat higher mortality of the larvae than otherwise would have been the case. The work by Lindquist *et al.* on house flies would indicate that the expected kill at 95° or even 100°F. would be lower than at 90°F.

In one test with a powder suspension of DDT, it was found that the relative differences in mortality at the two temperatures were much the same as those from DDT in Velsicol emulsion. DDT in powder suspension at 4 and 8 oz. per 100 gal. killed 80 and 100% respectively at 70°F., and 26.6 and 60.0% at 90°F.

Larvae of the greenhouse leaf tier ware used in one experiment and again marked differences in mortality due to temperature were noted, DDT (in Velsicol emulsion) at 4 and 8 oz. per 100 gal. killing 86.6 and 100.0% respectively at 70°F., and 43.3 and 76.6% at 90°F.

Effect of length of exposure to high or low temperatures. An attempt was made to find out what happened when treated insects were exposed to high

Table 2—Effect of temperature on contact action of DDT to diamondback moth larvae.

Percentage mortality

Oz. DDT per 100 gal.	70°F. Test A	70°F. Test B	70°F. Aver.	80°F. Test A	80°F. Test B	80°F. Aver.	90°F. Test A	90°F. Test B	90°F. Aver.	95°F. Test A
1	0	24.4	12.2	8.9	8.9	8.9	—	—	—	7.8
2	35.6	42.3	38.9	6.7	33.3	20.0	2.2	2.2	2.2	0
4	68.9	86.7	77.8	24.4	64.5	44.4	6.6	11.1	8.8	37.8
8	97.7	95.6	96.6	73.3	91.2	82.2	42.2	33.3	37.7	53.4
16	—	97.7	97.7	97.7	100.0	98.8	82.2	80.0	81.1	75.6
Check							2.2			0

Percentage of foliage eaten

Oz. DDT per 100 gal.	70°F. Test A	70°F. Test B	70°F. Aver.	80°F. Test A	80°F. Test B	80°F. Aver.	90°F. Test A	90°F. Test B	90°F. Aver.	95°F. Test A
1	41.6	43.3	42.4	46.6	66.6	56.6	—	—	—	46.6
2	21.6	23.3	22.4	73.3	38.3	55.8	21.6	33.3	27.4	61.6
4	0.6	1.0	0.8	18.3	10.0	14.1	18.3	25.0	21.6	20.0
8	T	T	T	2.0	T	1.0	4.6	23.3	13.9	11.6
16	—	0	0	0	0	0	0.6	13.3	6.9	3.3
Check							40.0			68.3

and low temperatures for varying intervals of time. A contact spray of DDT 4 oz. per 100 gal. (Velsicol emulsion) was applied to the insects which were then placed on untreated cabbage foliage in jars. One group of jars was then placed in a cabinet at 70°F. and another group in a second at 90°F. At the end of 6 hours one-third of the jars in each cabinet were transferred to the other cabinet, and after 24 hours another third from each were similarly transferred. The temperatures of the cabinets were not maintained at the given tempeatures but the fluctuation was not over 10°F. at any time. Three jars with 15 larvae each were used for each set of conditions and the experiment was run in duplicate, so the averages in Table 3 are for 90 larvae each.

The results at the end of 96 hours indicate that the full effect of the initial temperature is not produced by 6 hours exposure, but that it is by an exposure of 24 hours. The kill for the complete exposure at 70°F. was 96.2%; for a 24-hour exposure at 70°F. it was 85,4%, almost as high; but after a 6-hour exposure at 70°F., followed by 72 hours at 90°F., it was only 65.1%, indicating that in the last case the final temperature affected the mortality. The same general relationship held true when the initial temperature of 90°F. was followed by a temperature of 70°F.

Many more experiments are necessary to determine precisely the relationship between time and temperature on the toxicity of DDT.

EFFECT OF TEMPERATURE ON STOMACH ACTION OF DDT

After a spray of DDT on cabbage foliage had dried, pieces of leaves were placed in jars and unsprayed larvae added. A fault with this technique was that there was no way of controlling the amount eaten by the larvae. Although considerable more DDT-bearing foliage was consumed at the higher temperatures, the kill nevertheless tended to be less than at the lower temperatures as is illustrated by the results from two experiments. In the first experiment with DDT at 8 oz. per 100 gal. on 90 larvae at each temperature, the percentage mortality and percentage of foliage consumed respectively at the given temperature were as follows: at 60-62°F. — 62.2 and 0.5%; at 70-75°F. — 61.1 and 1.6%; at 90-96°F — 45.5 and 12%. In a second experiment, in which smaller pieces of leaf were used, the differences were more pronounced, as shown in Table 4.

Table 3. Effect of length of exposure to different temperatures on the contact action of DDT on diamondback moth larvae.

Time and temperature		Percentage mortality		
		Test 1	Test 2	
Hr. at 70°F.	Hr. at 90°F.	March 13	March 23	Average
0	96	30.0	53.4	41.7
6	90	52.5	77.8	65.1
24	72	97.5	73.3	85.4
Hr. at 90°F.	Hr. at 70°F.			
0	96	92.5	100.0	96.2
6	90	82.5	68.9	75.7
24	72	55.0	40.0	47.5

Table 4—Effect of temperature on stomach action of DDT on diamondback moth larvae. 45 larvae per treatment.

Oz. DDT per 100 gal.	Temperature and percentage mortality	
	60-70°F.	95°F.
0.5	53.4	11.1
1	53.4	17.8
2	60.0	13.3

An average of 91.6% of the foliage was consumed at 95°F. and 40.5% at 60-70°F.

CONCLUSIONS

These experiments, although far from precise owing to lack of suitable equipment, nevertheless showed definitely that the mortality by both contact and stomach action of DDT steadily decreased as the temperature rose within the range tested between 60° and 95°F. It is interesting to note that this held true for stomach poisoning even when considerably more of the treated foliage was consumed at the higher temperature than at the lower.

Lindquist has shown that temperature has a very similar effect on the toxicity of DDT to houseflies. It remains for physiologists to explain this marked difference in the sensitivity of insects to the action of DDT at different temperatures.

LITERATURE CITED.

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CROW EATING SERICA BEETLES (COLEOPTERA, SCARABAEIDAE).

On July 6, 1946, Game Warden, J. P. C. Atwood, of Vernon, B. C., saw a number of crows (*Corvus brachyrhynchos hesperis*) in coniferous trees adjacent to the highway, near where the Monte Creek road meets the Vernon-Kamloops road. He shot one on the wing, killing it in the air. The bird must have landed on its crop, for on reaching it he found its beak held wide open by a mass of beetles which also filled its throat and spilled out onto the ground.

Upon examining a sample of the insects two days later I found a large green and white phalaenid caterpillar, and a number of *Serica curvata* LeConte (det. W. J. Brown); one of the beetles was still alive. There were green needles of Douglas fir mixed in with the *Serica*, and it is presumed that they were feeding on the foliage of that species of tree. Atwood reports that, when he passed the same spot on June 13, there were many crows in the vicinity.

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THE SWEETCLOVER WEEVIL, *SITONA CYLINDRICOLLIS* FAHR.*

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Farmers in Manitoba and Saskatchewan have reported considerable losses of sweet clover from the attacks of a small, dark grey weevil, *Sitona cylindricollis* Fahr. This insect is widely distributed in central and southern Europe and occurs in Ireland, England, Germany and France. It is not known when it was first introduced to the North American continent. Brown (2) found it abundant in 1927 from Montreal, Que., to a point on the International Boundary near Hemmingford, Que., and the Canadian National Collection contains specimens taken at Hemmingford in 1924 and 1925. Brown also reports that this species was very abundant in the Ottawa, Ont., district in 1928 and that he took it at Shediac, N. B., in 1939. Hyslop (6) wrote that *S. cylindricollis* was first found in the United States in 1933 at Middlebury, Vt., and that it was collected at Storrs, Conn., Amherst, Mass., and on the New York side of Lake Champlain Valley. In 1935 Caesar (3) found it near Lindsay and Newmarket, Ont., where it was causing severe damage to sweet clover. It was first recorded in Manitoba in 1939 when a widespread infestation occurred. In 1940 it completely defoliated a field of sweet clover near Waldeck, Sask., and by 1943 it was abundant at Medicine Hat, Alta. Following this rapid spread through the continent it has shown periodic fluctuations. Severe damage occurred in Manitoba in 1939 and 1940. In 1941 and 1942 it was somewhat reduced, becoming severe again in 1943, 1944 and 1945.

Studies which form the basis for this preliminary report were conducted at Brandon, Man., in 1944 and 1945.

FOOD PLANTS AND DAMAGE

Adult weevils attack the foliage of sweet clover in the spring and fall, and the larvae feed on the roots during the summer. Leaf damage is very characteristic and is more readily noted than the weevils since these drop to the ground and remain quiet when approached. Crescent-shaped pieces are eaten out of the leaves. When damage is very severe the whole leaf surface with the exception of the midrib is consumed and the outer bark of the stems may be severely chewed.

Spring damage to seedling clover, if severe, may kill the plants. Yearling plants can usually outgrow the damage if there is sufficient moisture. Fall damage is often the most severe. Plants in a wide margin along the edge of a field may be completely stripped of every vestige of leaf surface. Associated with this defoliation there may be a severe infestation of root rot, *Rhizoctonia* sp., resulting in almost complete "winter killing". Plants not defoliated survive the winter much better.

Root damage by the larvae appears to be unimportant. The larvae feed on the root hairs and nodules and not on the tap root. Extensive sampling has established the fact that very few larvae develop on first year sweet clover.

Due to losses caused by the weevil and other contributing factors, there has been a reduction in the acreage sown to sweet clover in Manitoba. Alarm is expressed for the future of sweet clover in the province both by the agronomists who look on it as an important forage crop and by the apiarists who consider it the main source of honey.

Sweet clover is by far the favorite food plant of the weevils. All common varieties grown in Manitoba are attacked, as well as Ladina sweet clover and Melina sweet clover. Red clover and crown vetch are immune. Alfalfa may be severely defoliated if migrating weevils are forced on to it by the scarcity of sweet clover, but they do not appear to relish it. Rarely do fields of alfalfa show any sign of feeding by the weevil. In Russia, however, Yakhontov (9)

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records *S. cylindricollis* as feeding on lucerne and states that the larvae destroyed up to 87.5 per cent of the nodules of lucerne plants.

LIFE-HISTORY AND HABITS

The winter is passed in the adult state. Hibernation occurs in the upper inch of soil and in trash in the field in which the weevils were feeding prior to the onset of cold weather. Emergence from hibernation depends on the weather. In 1945 it did not occur until April 30, but that year the spring was exceptionally late. In 1946 the first weevils were seen on April 11. Emergence cages erected over the hibernation sites showed weevils emerging from the soil from early May to the end of July. There were two peaks of emergence in 1945, centering around May 21 and June 13, after which only a few individuals emerged. Comparison of these data with the weather records showed that the greatest emergence occurred during periods with mean daily temperature of about 60° F. preceded by rainfall.

Mating commences shortly after the weevils emerge from hibernation and start to feed. In 1945 many mating pairs were seen on May 16, and mating was observed well into July. At this time the overwintering generation was beginning to die.

Migration takes place both in the spring and fall. In the spring it is both by running and flying and in the fall by running only. On warm days in the spring the weevils run actively over the surface of the ground. In mid May weevils can be seen taking off in flight. They climb to the top of a clod of dirt, stubble or other elevation, spread their wings and make several attempts before they are able to take off. They fly with the wind at considerable speed at an elevation of about ten feet. Dispersal at this period must be considerable judging from the widely scattered damage that is observed both in the fields and to volunteer sweet clover.

In the fall after the hay crop of sweet clover is cut and the field tilled, the new generation of weevils migrates in large numbers. If there is an adjacent field of seedling sweet clover, they enter it in a regular army eating every vestige of foliage as they go. All feeding stops on a well-defined line with the onset of cold weather, and the weevils bury themselves under trash or work their way a short distance into the soil, where they hibernate. They may temporarily enter the hollow straws of the grain stubble grown as a companion crop but later leave them when the weather gets cold. As many as sixteen have been found in a single straw.

Oviposition commences in May and continues well into August. The eggs are white, quite smooth, dry and almost round, measuring on the average .381 by .300 mm. when laid. In 48 hours they turn black and average .389 by .288 mm. A female was observed ovipositing in loose soil several inches from a sweet clover plant. The eggs are dropped indiscriminately and roll down among the sand grains.

Weevils were found to oviposit readily in vials in the laboratory. Seventy-three pairs were isolated and these laid 29,158 eggs, or an average of 399.4 eggs per female. During the period studied, June 8 to August 21, the number of eggs laid per female ranged from zero to 1,665. As many as 72 eggs were laid in a day, and it was common for a female to lay 40 to 60 eggs per day for several days in succession.

On examining the records of the females that laid more than 1,000 eggs, it was observed that after laying for a number of days or weeks they had a rest period of as much as a month, after which they again laid freely. The length of the rest period varied with different individuals. The incubation period, as determined in the laboratory, varied from ten days to three weeks.

With such a protracted egg-laying period one would expect to find larvae in all stages of development on into early September. This, however, was not the case. It would appear that few eggs laid after the end of June produce larvae

TABLE 1.—NUMBER OF LARVAE, PUPAE AND ADULTS FOUND AT DIFFERENT DEPTHS

	2nd Instar					3rd Instar					4th Instar					Pupa					Adult					
Date	1"	2-3"	3-5"	5-7"	7-10"	1"	2-3"	3-5"	5-7"	7-10"	1"	2-3"	3-5"	5-7"	7-10"	1"	2-3"	3-5"	5-7"	7-10"	1"	2-3"	3-5"	5-7"	7-10"	Total
	SANDY SOIL																									
July 2	2	37	19	3	0	15	51	52	26	0	12	45	56	28	1											347
9	1	20	5	0	0	10	80	43	1	1	31	62	35	0	2											291
16	0	2	0	0		10	38	4	0		72	50	20	3		14	0	0	0							213
23						15	8	6	2		129	82	35	15		57	0	0	0		1	0	0	0		348
30	0	3	0	0	0	19	26	12	1	0	63	87	38	12	0	62	38	4	0	0	21	1	0	0	0	387
Aug. 8						0	1	0			8	8	1			46	5	0			75	10	0			154
9						5	7	1	0	0	88	28	14	1	1	43	7	2	0	0	66	9	3	1	0	276
16						1	0	0	0		14	10	6	0		38	4	1	1		20	10	0	0		105
23											1	4	0	0	0	11	1	0	0	0	217	21	7	0	0	262
31											0	4	0	0		1	0	1	0		97	18	6	0		127
Total	3	62	24	3	0	75	211	118	30	1	418	380	205	57	4	272	55	8	1	0	497	69	16	1	0	2510
	CLAY-LOAM SOIL																									
July 12	2	7	6	3	1	19	39	40	18	2	3	12	8	3	1											164
14						1	1				1	0														3
17	0	2	1	0	0	1	25	10	12	0	3	14	10	2	1											81
24	1	1	0	0		10	11	0	0		13	27	6	3		6	0	0	0							78
28						2	1				1	1				1	0									6
31						5	1	1			30	2	4			10	0	0			7	0	0			60
Aug. 9	0	1				1	3				14	15				78	12				52	7				183
14											12	5	1	0		53	15	2	0		183	42	6	3		322
18											1	0	0			0	0	0			0	0	0			1
24																1	0	0			2	1	0			4
Total	3	11	7	3	1	39	81	51	30	2	78	76	29	8	2	149	27	2	0		244	50	6	3		902

TABLE 2.—NOTCHES PER 100 LEAFLETS, JULY 13

Date of Seeding	Plots 1 to 5					Plots 6 to 10					Total	Ave.
	1	2	3	4	5	1	2	3	4	5		
1. April 25	210	217	154	149	131	116	99	92	119	137	1424	142
2. May 9	147	139	204	87	128	136	118	121	111	92	1283	128
3. May 23	123	107	117	106	139	150	157	183	140	141	1363	136
4. June 6	170	177	192	217	214	222	169	187	182	191	1921	192
5. June 20	149	125	152	163	153	166	149	154	144	157	1512	151
Total	799	765	819	722	765	790	692	737	696	718	7503	750
Average	160	153	164	144	153	158	138	147	139	144	1501	

which mature. Possibly hot, dry weather, which usually commences about July 1, desiccates the eggs and newly hatched larvae so that they do not become established on the roots of sweet clover. In Manitoba in 1945, probably less than 25 per cent of the eggs laid produced mature larvae.

Larval stages were determined by examining specimens secured by sifting soil at weekly intervals during July and August and by studying those hatching in the laboratory. The soil was sifted to a depth of 10 inches and records kept of larvae found at 1, 2 to 3, 3 to 5, 5 to 7 and 7 to 10 inch levels. A total of 2,078 larvae and pupae were obtained. The main series of siftings were made in second year clover on sandy and clay-loam soils.

The larvae were decapitated and the width of the head capsule measured with a micrometer. The results were graphed and an analysis made to determine the number of instars. The graph showed two prominent peaks, which are believed to be the third and fourth instars. First instar larvae were not secured by sifting but were obtained by rearing. Only a few larvae within the group which is considered to represent the second instar were found. This is probably due to the siftings being started too late in the season. Dyar's Law states that any linear measurement in successive instars of larvae are in geometric progression, or, if the logarithm of the linear measurement is plotted versus the number of the instar, a straight line results (5). Applying this to our case: Taking the peak of the second-last instar (3rd) at .521 millimeters, and the last instar (4th) at .822 millimeters, their ratio is .521:.822 or .63 millimeters. Calculating back (.521 x .63) we get .328 millimeters, which should be the peak of the next smaller instar (2nd). Taking .328 x .63 we get .206 millimeters, which checks roughly with the observed value for the first instar, .151 millimeters. We thus conclude that there are four instars in the larval stage of *S. cylindricollis*, the width of head capsules for each instar centering around .15, .32, .52, and .82 millimeters.

Migration of the larvae is indicated by a study of Table 1. Second and third instar larvae were found mostly in the 2 to 3 inch level. About half as many were found in the 3 to 5 inch level, with still smaller numbers down to 7 inches and only a few in the upper inch. The comparatively small numbers taken in the second instar may not show the true distribution of this stage at different depths. The fourth instar migrated up and pupation occurred in the upper inch in about 80 per cent of those recovered in our siftings.

Observations showed about 15 days were spent in the third instar and 16 in the fourth. The pupal period was 8 to 10 days. Newly emerged adults were first found on August 1 in 1945. They were brown and soft, while the remaining adults of the overwintering brood found at the same time were hard and black. Comparison of seasonal history on sandy soil and clay-loam indicated development was retarded about 6 days on the loam.

While hibernating quarters were sought at the onset of cool weather and the first frosts in late August, weevils could be found active on warm days in September and even October. At first many were found in the hollow stems of the companion crop stubble. Later they sought more permanent shelter under trash, weeds, sweet clover, and loose soil. Extensive sifting showed that the great majority were found in the upper inch.

NATURAL CONTROL

A fungus disease identified as *Beauvaria Bassiana* (Bals.) Vuill. killed a small percentage of weevils entering hibernation in the fall of 1944. In the spring of 1945, 27 per cent of the weevils were found dead of this disease on May 30. The organism *Fusarium scirpi* var. *acuminatum* (Ell. & Ec.) was also isolated from the weevils in the spring, but *Beauvaria* was considered the primary parasite. In Wisconsin, Allison (1) reported a great reduction of *S. cylindricollis* by a new species of the genus *Hirsutella*.

Weather undoubtedly greatly affects the activities of the weevils. Emergence from hibernation in the spring of 1945 was delayed until April 30. It continued until the end of July and was greatest during periods of a mean daily temperature of 60° F. preceded by rainfall. Weevils went into hibernation with the onset of cold weather, and activity ceased at the end of August, except for a few warm days in September. Probably the greatest effect of weather was indicated by the fact that few eggs laid after July 1 in 1945 produced larvae, thus cutting the potential increase by about 75 per cent. This was thought to be due to dry surface soil and high temperatures. The weevil is definitely cyclic in abundance, but its relationship to wet and dry years and the prevalence of the fungus disease caused by *Beauvaria Bassiana*, which is probably also affected by weather, has not been established.

A number of predaceous insects and vertebrates prey on the weevil. Telford and Munro (8) report toads eating many weevils. Franklin gulls were observed congregating on a field covered with adult *S. cylindricollis* and probably fed on them. No insect parasites have yet been reared from the weevil.

ARTIFICIAL CONTROL

Date of seeding is reported by Munro (7) as being an important factor in escaping early spring damage, late seeding suffering the least damage. To test this under Manitoba conditions, plots with two replicates were sown in 1944 on April 10 and 24, May 8 and 22, and June 5 and 19. Unfortunately not sufficient spring damage occurred to get data. The experiment was repeated in 1945 with sowings on April 25, May 9 and 23, and June 6 and 20. On June 6 and again on July 13 feeding notches on 100 leaflets in 10 locations picked at random in each plot, were counted. The results for July 13 are given in Table 2.

There was some indication that sowings on May 9 showed less damage, with greater damage for earlier and later sowing. The difference was probably not significant and was not sufficient to warrant making recommendations.

Summer tillage immediately after the hay crop of sweet clover has been taken off in late July or early August, is recommended by the Experimental Farms to conserve moisture by destruction of the clover plants and weed growth. At this time the weevils are in the late larval or the pupal stage, and the sudden cutting off of their food supply with disturbance of the soil should cause considerable mortality. To test this theory, in 1945 plots were one-way-disced 5 inches deep and ploughed 5 inches deep on August 4. At this time the majority of the weevils were in the pupal stage. Fifty emergence cages, each covering one square foot, were erected in both plots and the check, with the results shown in Table 3.

Table 3.—Adult emergence following summer cultivation

Check	averaged 28.5 weevils per sq. ft.	
One-way, 5",	averaged 27.1 weevils per sq. ft.	- 5% reduction
Ploughing, 5".	averaged 16.4 weevils per sq. ft.	—42% reduction

Although the emergence from the one-way-disced plot was only 5 per cent less than the check, the peak of emergence was delayed 10 days. This may be significant, as the feeding period of the weevils may have been reduced, and they may have gone into hibernation in a weakened condition. As the pupae and late fourth instar larvae were found in the upper inch of soil, surface tillage might be more effective than that 5 inches deep, as it would expose the fragile pupae and larvae to heat and desiccation.

Fall tillage when done in late October is designed to bury or disturb hibernating adult weevils so that they either fail to emerge in the following spring, or emerge so late that the larvae fail to become established. In the fall of 1944 plots were tilled, and, in the spring of 1945, 25 emergence cages were erected on each plot. The results of this work are presented in Table 4.

The peak emergence on all tilled plots was delayed until early July. As few larvae from eggs laid after July 1 survive, effective control was probably accomplished by tillage to a depth of only 3 inches.

Varietal resistance was considered as a possible means of control. Rep-

Table 4.—Emergence of hibernating adults following fall cultivation

Plough, 6"	1.2 ave. weevils per sq. ft. — 91% control
Plough, 3"	3.2 ave. weevils per sq. ft. — 75% control
Cultivate, 3"	4.5 ave. weevils per sq. ft. — 65% control
One-way, 3"	9.8 ave. weevils per sq. ft. — 25% control
Check No. 1, 11.9)	13.0 ave. weevils per sq. ft.
Check No. 2, 14.1)	

licated rod-row-plantings of the following varieties of sweet clover were mad in 1944 and 1945: Erector, Brandon Dwarf, Alpha No. 1, Hubam, Redfield Yel low, Arctic, Common White, Pioneer, Aura. Damage was estimated by takin random samples of leaflets and counting the feeding notches. While the dif ference between varieties in their susceptibility to weevil attack was not great some varieties appeared to have some resistance. Hubam, an annual sweet clove which was tested only in 1945, suffered the least damage. Comparing the varietie tested in both years, Erector placed first for least damage in 1944, third in 1945 and first in the average for the two years. Common White placed second fo both years and in the average for the two years. Pioneer, Alpha No. 1, and Red field Yellow, appeared definitely more susceptible to damage, while the othe varieties were intermediate. Hubam does not possess good agronomic charac eristics and is not grown commercially in Manitoba. Erector is the variety re commended by the Brandon Experimental Farm for planting in the Province

Crop rotation is certainly to be recommended in the control of an insec so restricted in its food habits. The new seeding of sweet clover should b planted as far as possible from that being grown for hay, but no data are avail able on the distance weevils fly in the spring migration.

Chemical control of the weevil is not considered practical on a field basi for a low-priced crop like sweet clover. However, a field test was run in 1945 one series of 3 replicates being made. The results presented in Table 5 wer determined by 3 observers making independent counts of living and dead see in 5 minutes at one spot in each plot.

Table 5.—Effects of insecticides in the control of sweetclover weevil

Poison	*Alive*	*Dead*	*Check*	*% reductio*
DN Sulphur	47	9	68	30.88
D.D.T. — Gesarol 3%	30	24	93	67.74
Barium Fluosilicate—pyrophyllite (1:3)	56	4	109	54.13
Alorco cryolite—pyrophyllite (2:1)	40	6	86	53.49

The DN sulphur, besides giving the lowest control, severely burnt the fo iage. This material is reported by Chamberlain (4) as showing promise of givin control.

SUMMARY

Sitona cylindricollis was introduced into North America from Europe. I was first collected in North America in 1924. It occurred in outbreak number in Ontario in 1936 and in Manitoba in 1939. By 1943 it had reached Alberta.

Sweet clover is found to be by far the favored host. The adults eat cre cent-shaped pieces out of the leaves, and the larvae feed on the root hairs o second year plants. Alfalfa is attacked only when sweet clover is scarce.

The adults overwinter in surface trash and soil to a depth of one inch They start to emerge from hibernation during the latter part of April, the pea being mid-May. Belated individuals continue to emerge until the end of July

Migration takes place in the spring by running and flying, in the fall onl by running.

Mating commences shortly after emergence. Egg-laying starts in May an continues to August, when the weevils die of old age. Seventy-three individual averaged 400 eggs each. The maximum for a single individual was 1,665. Th

eggs are at first white but turn black in 48 hours. They are dropped indiscriminately in the soil and hatch in from 10 days to 3 weeks.

Head capsule measurements of over 2,000 larvae indicate 4 instars.

The larvae penetrate the soil to a depth of 7 inches. The majority are found at the 2 to 3 inch level, with a good many at the 3 to 5 inch level. The fourth instar larvae migrate upward, and the pupae are found in the upper inch of soil.

The new generation commences to emerge in late July with a peak in early August. They feed actively but do not mate. They go into hibernation with the first frosts.

The fungus *Beauvaria Bassiana* (Bals.) Vuill. killed up to 27 per cent of the adults in 1945.

Weather affects the time of emergence from hibernation and determines the time when the weevils enter hibernation. Few eggs laid after July 1 survived in 1945, apparently due to hot, dry soil. This cut the potential increase by 75 per cent.

Toads and probably Franklin gulls feed on the adults. No insect parasites were observed.

Ploughing to a depth of 5 inches in early August after the hay crop was removed, reduced emergence by 42 per cent. One-way-discing to a depth of 5 inches, reduced emergence only 5 per cent. Shallow cultivation may be more effective by exposing larvae and pupae to desiccation and heat.

Ploughing 6 inches deep in October prevented 91 per cent of weevils from emerging from hibernation; ploughing 3 inches, 75 per cent; cultivating 3 inches, 65 per cent; one-way-discing 3 inches, 25 per cent. In addition, the peak of emergence was delayed to early July.

Some varieties of sweet clover appear to have a slight degree of resistance to weevil atack.

Crop rotation and planting of seedling clover at a distance from that grown for hay are to be recommended.

Dusting with 3% D.D.T. gave significant control.

ACKNOWLEDGEMENTS

The author is indebted to Alex Robson for tending the emergence cages, sifting soil for larvae, and obtaining egg-laying records. He also wishes to express his appreciation to Patricia Frith for making head capsule measurements, compiling graphs and tables, and making statistical analyses. Identification of disease organisms was made by Dominion Laboratory of Plant Pathology, Winnipeg, Man.

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HYDROPTILIDAE (TRICHOPTERA) FROM SOUTHERN UNITED STATES

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During the past several years a number of interesting collections of Hydroptilidae were made in the southern states, particularly in Louisiana, Georgia and Florida. These collections have now been examined and found to contain several new species and new distributional records of this little known family of "micro" caddis flies.

Unless designated otherwise types of new species described herein are in the author's collection at the University of Wyoming.

Oxyethira abacatia n. sp.

This interesting species is apparently closely related to *Oxyethira bidentata* Mosely; the lateral aspect of this Argentine species is modified in a very similar manner to *abacatia*. Diagnostic characters for the species are apparently limited to the genitalia.

Male. Length 2.4 mm. Genitalia as in fig. I. Sternite of seventh segment with mesal process prominent, acute apically. Most of ninth and tenth segments withdrawn into eighth segment. Viewed laterally eighth segment furcated, upper branch rounded and directed ventrad, lower branch heavily sclerotized and directed slightly dorsad. Near base of lower branch arises a small process, quite inconspicuous, bearing a few setae. Internal sclerotized portion of ninth segment with dorsal portion acute, tapering gradually ventrad, apex slightly upturned and directed laterad. Apex of oedagus somewhat bulbous, fig. 1A, considerably enlarged, semi-membranous, apparently divided into three lobes.

Holotype, male, Macon, Georgia, June, 1944, H. R. Dodge.

Oxyethira cibola n. sp.

This species is readily distinguished from other described species of the genus and from *maya* to which it is closely related by the oedagus and other details of the male genitalia.

Male. Length 2.3 mm. Body and wings light yellowish color. Abdomen without ventral processes. Diagnostic characters apparently restricted to genitalia.

Eighth segment not markedly specialized except deeply incised near ventro-lateral margin. Ninth and tenth segments largely withdrawn into eighth segment, fig. 2. Ninth segment and internal ventral lobe long, slender, extending just into sixth segment, forming an endoskeleton to which a pair of heavily sclerotized bulbous plates, the claspers, are located ventrally, fig. 2, and fig. 2A. Ventrally, the ninth segment extended caudad as a somewhat circular plate reaching nearly to distal margin of claspers, fig. 2A. Lateral lobe of ninth segment truncate when viewed laterally. Tenth segment with a pair of stiliform appendages bearing a long fine seta apically. Near base of tenth segment is a small wart bearing a spur which reaches just beyond the margin of the eighth segment, fig. 2. Oedagus, fig. 2C, gradually tapering to the neck; main apical portion tapers suddenly to a slender rod sharply curved at apex, in this respect similar to *Oxyethira verna* Ross; two other filamentous rods are twisted around the main portion, the one which is twisted most completely with a sharp hook at apex; apical portion of main body enclosed in a membranous area.

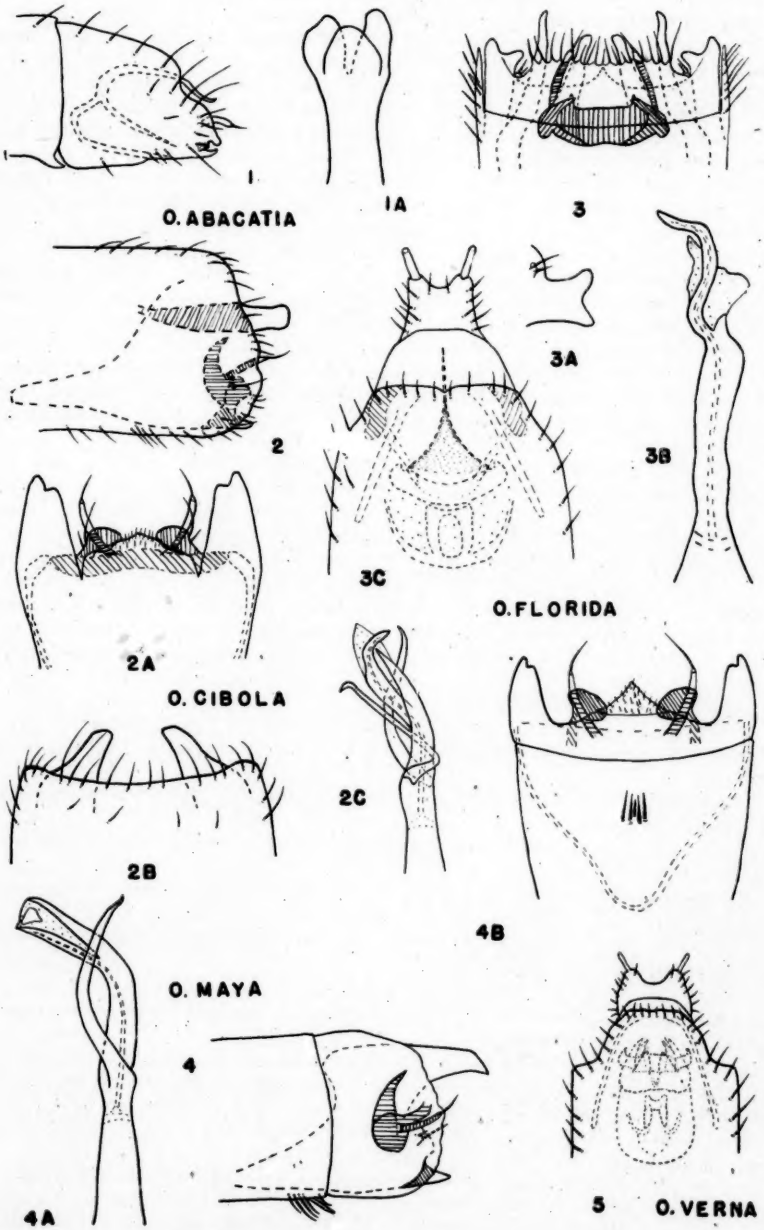
Holotype, male—Macon, Georgia, June, 1944, H. R. Dodge.

Paratypes,—Georgia.—same data as for holotype, July, 1944, 2 males.

Oxyethira florida n. sp.

This species is apparently most closely related to the *cibola-maya* section of the genus. It can be readily separated from these and other described species by the curiously twisted oedagus and other details of the male genitalia.

PLATE I.



HYDROPTILIDAE FROM SOUTHERN UNITED STATES

Male. Length 1.7 to 2.3 mm. Genitalia as in fig. 3. Mesal portion of seventh segment bears a minute acute process held nearly parallel to the sternite. Seventh segment produced into long slender setose lobes, viewed ventrally, fig. 3. Eighth segment considerably reduced, ventral margin strongly serrate; inner surface bi-emarginate, its mesal lobe triangular and covered with setae. Ventro-lateral portion of eighth segment produced into a heavily sclerotized process, apical margin concave; internal aspect when viewed laterally, shows small process near base bearing a few setae, fig. 3A. Internal portion of ninth segment with ventral lobe long and slender, extending nearly to margin of sixth segment; dorsal lobe acute, flattened. Apically, dorsal lobe produced into a long slender process, extending beyond any other portion of genital capsule, when seen from lateral aspect apex directed dorsad. Apparent claspers produced beyond margin of eighth segment a distance almost equal to one-half their length; apex rounded, when viewed from lateral aspect only slightly directed ventrad. Arising from the internal tenth segment is a pair of smooth one-segmented appendages, lying along side the claspers and bearing a prominent seta apically. Oedagus arises at a point one-half distance in the sixth segment; basal portion long, gradually tapering to the neck; apical portion slender throughout but tapers suddenly to form a much twisted appendage which is sharply curved apically, degree varying somewhat; at point of constriction a small digitate process from which a membranous fold arises, fig. 3B.

Female. Genitalia as in fig. 3C. Eighth sternite with apical margin emarginate; eighth tergite with apical margin irregularly rounded; entire segment with considerable setae. Ninth sternite with apical margin rounded; ninth tergite with apical portion a rounded projection bearing a cushion of very minute spicules; basal corners produced into a pair of slender rods directed gradually laterad. Tenth segment with apical margin emarginate. Seen from ventral aspect bursa copulatrix with a heavily sclerotized portion, supported dorsally to internal sclerotized portion of ninth segment; caudad to this structure is a prominent acuminate plate projected caudad nearly to apical margin of ninth sternite.

Holotype, male—Miami, Florida, Feb. 1, 1945, D. G. Denning.

Allotype, female—Miami, Florida, Oct. 1, 1944, D. G. Denning.

Paratypes, four males—Miami, Florida, Nov. 15—30, 1944, Light trap, D. G. Denning.

Paratypes, three males, eleven females—Miami, Florida, Oct. 12—30, 1944, Light trap, D. G. Denning.

Paratypes, five males, six females, Miami, Florida, Oct. 1, 1944, Light trap, D. G. Denning.

Paratypes, five males, nine females, Miami, Florida, March 1—15, 1945, D. G. Denning.

Paratypes, seventeen males, twenty-nine females, Miami, Florida, Feb. 2—8, 1945, Light trap, D. G. Denning.

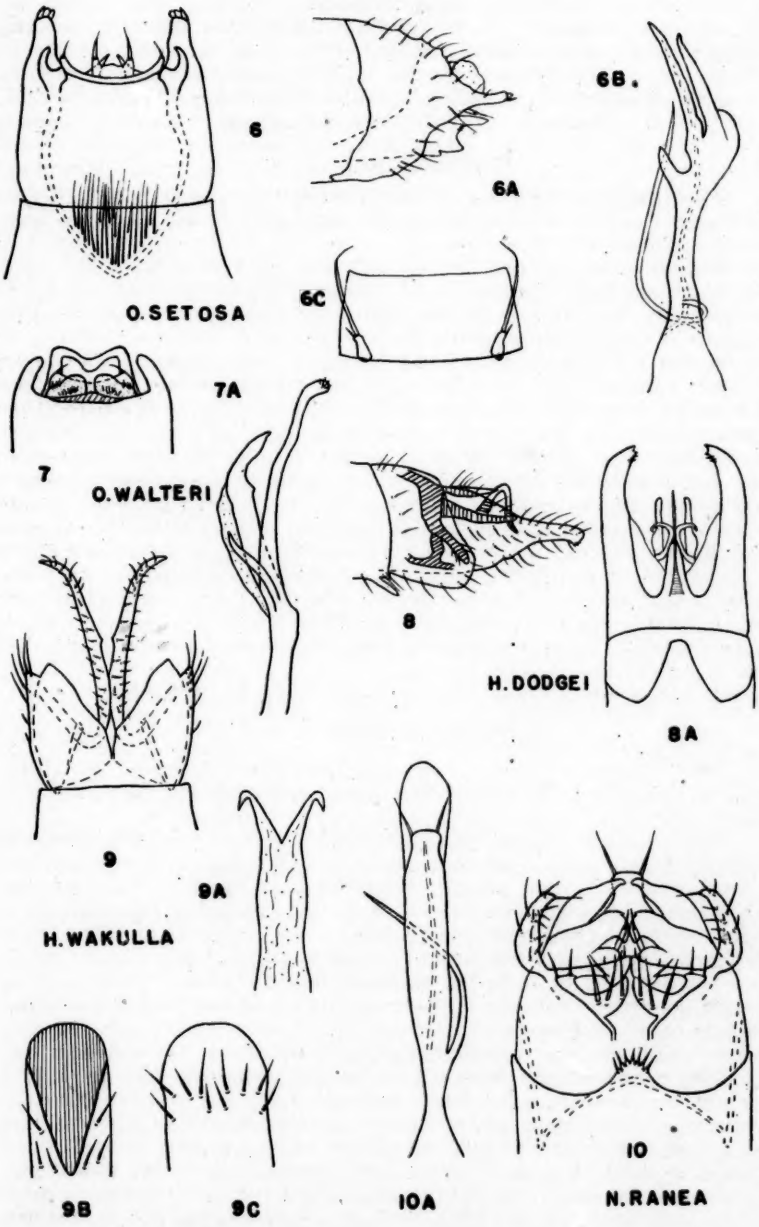
Oxyethira glasa Ross

This species has not been recorded since its original description from a specimen taken in Oklahoma.

This species was found to be especially abundant in southern Florida as the following records would indicate. No doubt the species will eventually be found in most of the southern states.

Florida: Miami	February 1—8, 1945, Light trap, D. G. Denning, 2 males.
Miami:	February 15, 1944, D. G. Denning, 19 males.
Miami:	February 23—28, 1944, D. G. Denning, 16 males.
Miami:	March 1—15, 1945, Light trap, D. G. Denning, 2 males.
Miami:	November 15—30, 1944, Light trap, D. G. Denning, 16 males.

PLATE II.



HYDROPTILIDAE FROM SOUTHERN UNITED STATES

Miami: December 4, 1944, D. G. Denning, 14 males.
Miami: December 14–15, 1944, Light trap, D. G. Denning, 28 males.
Miami: December 20, 1944, D. G. Denning, 4 males.
Louisiana: New Orleans: August 7, 1945, D. G. Denning, 1 male.
New Orleans: August 20, 1945, D. G. Denning, 1 male.
Georgia: Macon: May 31, 1945, H. R. Dodge, 2 male, 1 female.
Macon: July, 1944, H. R. Dodge, 4 males, 1 female.

Oxyethira maya n. sp.

This species, while closely related to *Oxyethira cibola*, is readily distinguished from it and other described species of the genus by the distinctive oedagus and other features of the male genitalia.

Male. Length 2.25 mm. Wings and body light yellowish color. Ventral aspect of seventh segment with a group of flattened setae, four large and similar in size, the fifth much shorter, fig. 4B. Gross characters typical of genus; diagnostic characters apparently restricted to male genitalia.

Eighth segment slightly incised latero-ventrally, enclosing most of ninth and tenth segments. Ninth segment modified as follows: ventral portion produced into a pair of prominent heavily sclerotized claspers, between them the segment is extended posterad beyond their margins as a triangular setiferous plate, fig. 4B. Arising from the upper portion of these plates is a wart bearing a long and a short seta. The remaining ninth segment produced ventrad into a long slender lobe extending just into the sixth segment. Lateral lobes short, rather slender, apico-ventral angle produced into a sharp point, fig. 4; claspers extend directly posterad, in the specimen examined they are asymmetrical. Tenth segment with a pair of stiliform appendages tipped with a long fine seta. Oedagus with basal portion long, narrow, tapering gradually to the neck; main body is furcated apically; apical portion with a membranous sheath open in apical portion, near point of construction arises a heavily sclerotized rod, slightly twisted and with a slight hook apically, fig. 4A.

Holotype, male—Macon, Georgia, June, 1944, H. R. Dodge.

Oxyethira setosa n. sp.

Gross characters typical of genus; diagnostic characters apparently restricted to the remarkably developed oedagus and other details of the genital capsule.

Male. Length 2.9 mm. Sternite of fifth segment with a pair of finger-like processess near posterio-lateral margin bearing a short and a very long slender seta which extends beyond margin of fifth segment, fig. 6C. Mesal portion of seventh sternite bearing a dense brush of flattened setae. Eighth segment with a large number of prominent setae; when viewed from lateral aspect, fig. 6A, quite heavily sclerotized, irregular and extending posterad as a slender, quadrate process bearing a set of three flat leaflets apically. Internal portion of ninth segment a slender rod with a prominent heavily sclerotized hook apically, directed slightly mesad, best observed ventrally, fig. 6. Seen from ventral aspect and between these hooks is a complicated series of structures: 1st, a slender curved rod bearing a process near base of hook with a prominent seta apically; 2nd, near center a pair of somewhat larger processes bearing a seta; 3rd, near center a slender, acute, somewhat more heavily sclerotized process directed mesad. Tenth tergite a membranous plate. Oedagus long, extending one-half distance into sixth segment, bearing a slender filamentous rod which twists around oedagus near constriction. Apical portion divided into three heavily sclerotized projections; the first short, the next, through which the duct passes, slender and acute, the next somewhat wider and more acute apically, fig. 6B.

Holotype, male.—Macon, Georgia, June, 1944, H. R. Dodge.

Paratype, male.—Same data as for holotype.

Oxyethira verna Ross

This species has been recorded from New Brunswick and Illinois by Ross. The present distributional data represents an enormous increase in its known geographical range. Additional collections will probably prove its presence throughout the South. It was the most abundant species of Hydroptilidae encountered in southern Florida.

The large series examined presented considerable variation in the ventral plate, between the claspers, when viewed from the ventral aspect. This varied from a condition nearly straight as illustrated by Ross to one that was deeply emarginate. Dr. H. H. Ross, in a personal communication, states that he also found similar variations in additional specimens that he has checked.

Allotype, female.—New Orleans, Louisiana, May 1—15, 1946, light trap, D. G. Denning.

Female genitalia as in fig. 5. Eighth sternite with apical margin produced into a large somewhat rounded projection, its apex truncate and a trifle irregular. Ninth sternite narrow, inconspicuous, its apical margin arcuate, bearing no setae. Ninth tergite quite heavily sclerotized, apex rounded, densely covered with minute spicules, ventral corners produced into a pair of internal rods, long and slender. Tenth segment with apical margin emarginate, bearing a pair of styles with very minute spicules at apex. Seen from ventral aspect bursa copulatrix with three pairs of teeth apically and dorsad to them a narrow band with latero-distal portion produced into a small acute process; basal portion rounded with mesal area supporting a distinct sclerotized process.

Florida:	Miami:	February 1—8, 1945, Light trap, D. G. Denning, 168 males, 92 females.
	Miami:	February 15, 1944, D. G. Denning, 11 males.
	Miami:	February 23, 1944, D. G. Denning, 3 males.
	Miami:	March 15—30, 1945, D. G. Denning, 12 males.
	Miami:	April 10, 1944, D. G. Denning, 5 males.
	Miami:	October 1—3, 1945, Light trap, D. G. Denning, 56 males, 28 females.
	Miami:	October 12—30, 1944, Light trap, D. G. Denning, 25 males, 31 females.
	Miami:	November 15—30, 1944, Light trap, D. G. Denning, 34 males.
	Miami:	December 4, 1944, D. G. Denning, 18 males.
	Miami:	December 14—15, 1944, Light trap, D. G. Denning, 23 males.
	Miami:	December 20, 1944, Light trap, D. G. Denning, 32 males.
Louisiana:	New Orleans:	May 1—15, 1946, Light trap, D. G. Denning, 37 males, 56 females.
	New Orleans:	May 16—22, 1946, Light trap, D. G. Denning, 12 males.
	New Orleans:	June 25, 1946, D. G. Denning, 2 males.
	New Orleans:	July 3, 1945, Light trap, D. G. Denning, 1 male, 2 females.
	New Orleans:	August 20—27, 1945, Light trap, D. G. Denning, 8 males, 13 females.
	New Orleans:	October 15, 1945, D. G. Denning, 2 males.
	New Orleans:	November 10, 1945, D. G. Denning, 1 male.
	New Orleans:	December 3, 1945, Light trap, D. G. Denning, 1 male, 2 females.

Oxyethira walteri n. sp.

This species is closely related and similar to *Oxyethira zeronia* Ross which has been taken in Michigan and northeastern Illinois. It differs from *zeronia*

in the oedagus and other details of the male genitalia. This species has thus far been found only in the extreme southern portion of the United States.

It is with great pleasure that I name this species in honor of Dr. O. F. Walter of Macalester College, St. Paul, Minnesota, who has on many occasions encouraged and aided the writer in his entomological studies.

Male. Length 2.9 to 4 mm. Genitalia as in fig. 7. A large series of this species was consistently larger than *zeronia;* it is at present one of the largest known members of the genus. Sternite of seventh segment with no apical projection as in *zeronia.* Lateral portion of eighth segment produced into a short apically rounded lobe; ventral margin bi-emarginate. Ventro-basal internal portion of ninth segment very long, the two lateral projections very near one another for about one-half their length, extending into sixth segment for about one-fourth its width. Claspers setose, small and heavily sclerotized, distinctly separated from one another by a short distance; mesal margin nearly straight, apical margin rounded, outer lateral margin elongated and considerable narrowed. Directly above the claspers, fig. 7, are a pair of large lightly sclerotized processes, bearing a prominent spur apically. Dorsad to these is a heavily sclerotized rod-like projection, apparently a portion of the ninth segment, which forms a ventral collar upon which the oedagus rests when extended; in all specimens examined this projection reached beyond the lateral lobes of the eighth segment. Tenth tergite membranous, extending posterad beyond remainder of genitalia. Oedagus slender, very long, somewhat sinuate; it arises at a point slightly in the sixth segment. Apical portion of oedagus consists of three projections, a short slender appendage, considerably longer than in *zeronia;* a heavily sclerotized appendage acute and sharply curved apically, along its side a membranous fold; a slender lightly sclerotized appendage, considerably longer than remainder, somewhat sinuate in some specimens, nearly straight in others, apical portion slightly curved, bulbous, bearing a group of about five minute setae, fig. 7A.

Holotype, male—Florida: Miami: November 30, 1944, Light trap, D. G. Denning.

Paratypes, Miami: March 15, 1945, D. G. Denning, 6 males.
Miami: May 10, 1944, D. G. Denning, 12 males.
Miami: November 15, 1944, D. G. Denning, 4 males.
Miami: December 20, 1944, D. G. Denning, 1 male.
Louisiana: New Orleans: May 14, 1945, D. G. Denning, 1 male.
New Orleans: August 7, 1945, D. G. Denning, 1 male.
Georgia: Macon: June, 1944, H. R. Dodge, 2 males.

Orthotrichia americana Banks

This species has a wide range through an area from Texas to New York to Minnesota in the North. The following records represents a considerable southeastern extension in its known range. Second to *Oxyethira verna* it was the most frequently encountered species in southern Florida, where it is apparently present throughout the year.

Florida: Miami: October 1–3, 1944, Light trap, D. G. Denning, 40 males, 7 females.
Miami: October 12–30, 1944, D. G. Denning, 7 males, 2 females.
Miami: November 15, 1944, D. G. Denning, 1 male, 1 female.

Miami: February 1–8, 1945, Light tr.p, D. G. Denning, 21 males, 15 females.
Miami: March 15, 1945, Light trap, D. G. Denning, 1 male.
Miami: May 10, 1944, D. G. Denning, 14 males, 12 females.
Georgia: Macon: May, 1944, H. R. Dodge, 1 male, 2 females.
Macon: July, 1944, H. R. Dodge, 4 males.

Orthotrichia cristata Morton

This species has a range somewhat similar to *americana* Banks, but extending further west into Montana and British Columbia as shown by Ross. Collections from Georgia and Florida represent a considerable southeastern extension in its known range.

Georgia: Macon: August, 1944, H. R. Dodge, 1 male.
Florida: Miami: April 10, 1944, D. G. Denning, 1 male and 1 female.

Hydroptila dodgei n. sp.

This species is remarkably different from other described species of the genus. Gross characters typical for genus; diagnostic characters apparently confined to genitalia. So called "scent caps" large, dark, very prominent, occupying most of posterior region of head.

I take great pleasure in naming this species in honor of Dr. H. R. Dodge, who not only collected this species, but has also collected many other new or little known species of Trichoptera.

Male. Length 2.75 mm. Genitalia as in fig. 8. Sternite of seventh segment with a very lightly sclerotized lancelate shaped mesal process. Eighth segment little modified; portion of internal sclerotized ninth segment, projected a considerable distance posterad, irregular, sub-quadrate apically, apex with five heavily sclerotized teeth; observed dorsally, fig. 8A, directed gradually mesad; whole with prominent setae. Tenth tergite small, vasiform. Immediately below tenth tergite arises a filamentous rod, strongly divergent, directed suddenly dorsad and then abruptly ventrad, acute apically. Below these appear a pair of slender processes directed posterad, mesal margin nearly straight, apex rounded. Oedagus slender and acute, rod-like, extending slightly beyond the above processes.

Holotype, male—Georgia: Macon: June, 1944, H. R. Dodge.

Hydroptila wakulla n. sp.

This species belongs to the *salmo* Ross, *waubesiana* Betten, *acadia* Ross section of the genus. It can readily be distinguished from those species by the claspers and the hook-like apex of the tenth tergite.

Male. Length 2.3 mm. Seventh sternite with a small acuminate mesal projection. Ninth segment mostly retraced into the eighth segment; seen from dorsal aspect, fig. 9, only a small portion of the lateral and apical margin protrudes beyond the eighth segment. Tenth tergite very long, prominent, mostly membranous, reaching almost to apex of claspers; apical portion divided into a pair of divergent lobes, apex of each developed into a sclerotized sharp hook, fig. 9A; seen from lateral view depth exceeds its width, apical portion upturned. Claspers long, slender, bearing a number of short setae, touching near base then gradually divergent; a distinct point about midway along mesal margin, apex slender, acute, directed laterad; viewed from lateral aspect they project posterad in a straight line. Oedagus arises near anterior margin of sixth segment; very slender, a thread-like projection encircles it; in general very similar to that described and illustrated for *acadia* Ross.

Female. Length 2.7 to 4.1 mm. Apical margin of eighth sternite arcuate, mesal portion somewhat truncate, irregular arrangement of 8 to 10 setae, fig. 9C. Eighth tergite with apical margin deeply incised for a distance not quite equal to one-half length of segment, although length of incision is somewhat variable, near lateral margin an irregular group of six setae, fig. 9B.

Holotype, male—Florida: Wakulla Springs: October 23, 1945, D. G. Denning.

Allotype, female—Same data as for holotype.
Paratypes—Same data as for holotype. 1 male, 8 females.

Hydroptila waubesiana Betten

Ross has recorded this species from Wisconsin, Illinois, Indiana, Michigan, Ohio, Ontario, and Saskatchewan. The collecting of this species in the lower Mississippi delta was wholly unexpected and thereby leaves a large gap in its known range.

Louisiana: New Orleans: (emerging from Lake Pontchartrain) May 10, 1946, D. G. Denning, 23 males and females.
New Orleans: May 14, 1945, D. G. Denning, 1 male.
New Orleans: August 14, 1945, D. G. Denning, 1 male, 3 females.
New Orleans: October 10–15, 1945, D. G. Denning, 5 males.

Neotrichia minutisimella (Chambers)

This smallest known species of caddis fly in North America has been recorded by Ross from Missouri, Oklahoma, Illinois, Indiana, and Kentucky. The following record represents a considerable southward extention in its known range.

Louisiana: New Orleans: August 7, 1945, D. G. Denning, 2 males.

Neotrichia ranea n. sp.

This species is related to *vibrans* Ross. It can be readily distinguished from that and other discribed species by the curious oedagus and other details of the male genitalia. Apparently diagnostic characters are restricted to the male genitalia.

Male. Length 1.5 mm. Apical margin of the eighth sternite with a somewhat circular mesal projection, its margin divided into small leaflets each bearing a flattened seta. Genitalia viewed from ventral aspect, fig. 10, with the following paired appendages: the claspers, somewhat irregular in outline and bearing a few scattered setae, apical portion directed mesad; between the base of the claspers, a pair of complicated structures bearing several very prominent setae; a heavily sclerotized, stocky pair of appendages, apical portion hammer-shaped, the caudo-mesal angle with a distinct point, arising from near its base a pair of inconspicuous one-segmented appendages bearing a prominent seta apically; dorsally a pair of appendages without setae, the apex gradually narrowing to a point, directed ventrad when viewed laterally. Oedagus, fig. 10A, arising from anterior portion of sixth segment, base wide, tapering abruptly to a very narrow neck, apex quadrate, bearing two prominent setae, a membranous hood-like projection extends beyond setae; a long slender appendage arises from neck and is almost as long as the main body of the oedagus.

Holotype, male—Miami, Florida: May 10, 1944, D. G. Denning.
Paratype, male—Macon, Georgia: July, 1944, H. R. Dodge.

EXPLANATION OF PLATES I AND II

Fig. 1, *Oxyethira abacatia*, lateral aspect; 1A, oedagus, apex.
Fig. 2, *Oyethira cibola*, lateral aspect; 2A, ventral aspect; 2B, dorsal aspect; 2C, oedagus.
Fig. 3, *Oxyethira florida*, ventral aspect; 3A, internal lateral aspect; 3B, oedagus; 3C, female genitalia, ventral aspect.
Fig. 4, *Oxyethira maya*, lateral aspect; 4A, oedagus; 4B, ventral aspect.
Fig. 5, *Oxyethira verna*, female genitalia, ventral aspect.
Fig. 6, *Oxyethira setosa*, ventral aspect; 6A, lateral aspect; 6B, oedagus; 6C, fifth segment, ventral aspect.
Fig. 7, *Oxyethira walteri*, ventral aspect; 7A, oedagus.
Fig. 8, *Hydroptila dodgei*, lateral aspect; 8A, dorsal aspect.
Fig. 9, *Hydroptila wakulla*, dorsal aspect; 9A, tenth tergite, dorsal aspect; 9B, female, eighth tergite; 9C, female, eight sternite.
Fig. 10. *Neotrichia ranea*, ventral aspect; 10A, oedagus.